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Odonata from the Lanjak Entimau Wildlife Sanctuary, Sarawak

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Abstract

Records of Odonata from the Lanjak Entimau Wildlife Sanctuary (LEWS) in Sarawak, Malaysian Borneo are presented. Previous records of Odonata from LEWS are critically examined. One hundred and ten species have been recorded within the sanctuary, including three that have yet to be found outside (Drepanosticta adenani, Telosticta iban and “Elattoneura” mauros); records of four more species are regarded as in need of confirmation, those of another six are incorrect. In addition to the three species only known from LEWS, other notable records include: Drepanosticta sbong, Dysphaea lugens, Euphæa sp. cf basalis, Pericnemis kiataurum, Burmagomphus insularis, Gomphidia caeserea, Merogomphus species, Phaenandrogoomphus safei, Macromia callisto and Idionyx montana. A fresh illustration of the anal appendages of Drepanosticta sbong in lateral view is provided to make up for inaccuracies in the original illustration. The taxonomy of Phaenandrogoomphus safei is briefly discussed. Zygonyx errans Lieftinck, 1953 is considered a subspecies of Z. ida not Z. iris. Additional records from areas adjacent to LEWS are given in an appendix.
Bahasa Melayu Abstract

Key words: Malaysia, Borneo, Sarawak, LEWS, Drepanosticta sbong, Phaenandrogomphus safeii, checklist, Odonata at light, Zygonyx ida errans Lief tinck, 1953 stat. nov.

Introduction
The Lanjak-Entimau Wildlife Sanctuary (LEWS) is an extensive area of mainly lowland forest in Sarawak, situated between 1.325N and 1.833N and 111.89E and 112.475E and spread across the administrative divisions of Kapit, Sarakei, Sibu and Sri Aman.

Figure 1. Map showing the location of LEWS in Sarawak.
in Sarawak (Fig. 1). LEWS was constituted and gazetted in 1983 under The Wild Life Protection Ordinance 1958, with the purpose of protecting all wildlife in the area, especially orangutans and hornbills. Subsequently in 2013 the LEWS Extension I was gazetted to allow more areas to be protected and at the same time demonstrate the commitment of the government to wildlife conservation in Sarawak.

Elevations in LEWS range from 60m a.s.l. to 1,285m a.s.l. The highest peak in LEWS is Bukit Lanjak, followed by Bukit Sengayoh (899m a.s.l.) in the north and Bukit Entimau (795m a.s.l.) in the west. Other high points in LEWS include Bukit Sengkajang, Bukit Spali, Bukit Lumut, Bukit Awai and Bukit Peninjau. LEWS has eight distinct forest types: riparian, alluvial, lowland and old secondary forest at lower elevation and hill, summit ridge, sub-montane and montane mossy forest at higher elevations.

In 1997, the ITTO Borneo Biodiversity Expedition 1997 (Kuswanda et al. 1999) to LEWS recorded nearly 3,000 plant (tree, shrub, climber, epiphyte etc.) species, 521 fungi, 42 lichen, 1,050 insect, 117 amphibians, 203 terrestrial and freshwater reptiles, 82 fish, 238 birds including 7 hornbill species, 58 non-primate mammals, and 6 primates. The data collected over the past 20 years need to be updated and, in some cases, needs to be verified.

LEWS shares its southern boundary with Batang Ai National Park (BANP, also in Sarawak) and Betung Kerihun National Park (BKNP, in Indonesia). As part of the regional conservation initiative, LEWS has been selected as one of the three components of the Trans-boundary Conservation Area (TBCA), along with BANP and BKNP. LEWS is also one of the sites under the Heart of Borneo (HoB), a tri-lateral agreement signed in 2005 between Malaysia, Brunei and Indonesia.

Administratively, LEWS is divided into three administrative areas, these are: Nanga Bloh station, the head office for LEWS, located at Ulu Katibas, Song, Kapit, near the

Figure 2. Satellite image showing the locations of the LEWS stations. Base image from Google Earth.
mouth of Sungai Bloh (nanga means river mouth in Iban, the dominant Dayak language of the areas around LEWS); Nanga Ju ranger station at Ulu Mujok, Julau, Sarikai; and Nanga Segerak field research station at Ulu Engkari, Lubok Antu, Sri Aman. Each station has its own management present on-site. The locations of the stations are shown in Fig. 2 (see also Fig. 6, 9, 10).

LEWS is accessible from the nearby towns and settlements by river (e.g. see Fig. 3) and some locations can be reached by logging roads. Nearby logging concessions have created relatively easy access to all the field station areas, and other areas. The newly constructed road from Kanowit town to Song and then, eventually, to Kapit town will greatly increase the accessibility to the Ulu Katibas area, thus creating more management challenges for LEWS.

In response to these management challenges, the state of Sarawak launched, in 2015, a new biodiversity research initiative called the Research for Intensified Management of Bio-rich Areas (RIMBA) Sarawak project. Under the RIMBA platform, sites in LEWS and other selected Totally Protected Areas (TPAs) of Sarawak have been opened for research by renowned international institutions through collaboration with the Sarawak Forestry Corporation (SFC) for the purpose of developing intensive, practical conservation management procedures for sustainable conservation of Sarawak’s rich biodiversity.

Two areas of LEWS have been selected as sites for the RIMBA Sarawak project. These sites, Nanga Bloh station in Ulu Katibas and Nanga Segerak in Ulu Engkari, were selected due to their unique biodiversity and as the home of iconic wildlife species: orangutan and hornbills. Nanga Ju (Figs. 4, 5) is not included as one of the main RIMBA sites, how-

Figure 3. On route to Nanga Segerak station on Sungai Engkari. Photo by G.T. Reels.
Odonata from the Lanjak Entimau Wildlife Sanctuary, Sarawak

Figure 4. Nanga Ju station. Photo by R.W.J. Ngiam.

Figure 5. Relaxing at Nanga Ju station. Photo by R.W.J. Ngiam.
ever it is regarded as an important site to provide connectivity between Nanga Bloh and Nanga Segerak. The other three current RIMBA sites are Ulu Sebuyau National Park, Miri-Sibuti Coral Reef National Park and Nanga Lubang Baya, Batang Ai National Park.

Prior to 2008 no records of Odonata were available from LEWS that we are aware of. In 2008 an expedition jointly organised by the Malaysia Academy of Sciences, Forestry Department Sarawak and Universiti Malaysia Sarawak was made to the area of the Nanga Bloh Field Station in LEWS on 16-29 June. Two groups studying Odonata were present on the 2008 expedition, one from Universiti Malaya (UM) and one from Universiti Kebangsaan Malaysia (UKM); one of the authors of this paper (C.Y. Choong) was part of the latter group. The Odonatological results of both groups present during the 2008 expedition were published in Norma-Rashid et al. (2010). However some of the records in Norma-Rashid et al. (2010) are dubious or, in some cases, clearly incorrect, and few details of the material collected are given.

Table 1: Dates and stations of trips during which Odonata were collected at LEWS.

<table>
<thead>
<tr>
<th>Year</th>
<th>Dates</th>
<th>Station</th>
<th>Authors present</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>16th–28th June</td>
<td>Nanga Bloh</td>
<td>C.Y. Choong</td>
</tr>
<tr>
<td>2013</td>
<td>20th–26th August</td>
<td>Nanga Bloh</td>
<td>R.A. Dow</td>
</tr>
<tr>
<td>2015</td>
<td>26th July–7th August</td>
<td>Nanga Ju</td>
<td>R.A. Dow</td>
</tr>
<tr>
<td>2016</td>
<td>9th–16th March</td>
<td>Nanga Bloh</td>
<td>R.A. Dow &amp; S.G. Butler</td>
</tr>
<tr>
<td>2016</td>
<td>13th July–22nd July</td>
<td>Nanga Segerak</td>
<td>R.A. Dow &amp; G.T. Reels</td>
</tr>
<tr>
<td>2017</td>
<td>30th October–12th November</td>
<td>Nanga Bloh</td>
<td>R.A. Dow</td>
</tr>
</tbody>
</table>

Between 2013 and the present the other authors of the report have, in various combinations, visited various parts of LEWS (see Table 1); the results of this collecting are presented here. Specimens collected by C.Y. Choong on the 2008 expedition are also listed in detail, as well as other non-controversial records from Norma-Rashid et al. (2010), so that a complete list of the Odonata currently known from LEWS is presented. Records from Norma-Rashid et al. (2010) that require confirmation, or that are obviously incorrect, are discussed. In total at least 110 species of Odonata are now known to occur in LEWS, with four additional species recorded by Norma-Rashid et al. (2010) regarded as in need of confirmation here.

List of Odonata known from LEWS

Locations

The following codes are used for locations where sampling was carried out. Coordinates are given where available.

Nanga Bloh

Altitude on sampled parts of Sungai Katibas ca 120-148m. The locations of some of the sampling sites are shown in Fig. 6.
Figure 6. Satellite image showing some of the sampling sites in the Nanga Bloh area. Base image from Google Earth.

1. Open marshy pools at Nanga Bloh Field Station, and around the field station (1.6451N, 112.2773E).
2. A small, high gradient stream at Nanga Bloh Field Station (tributary of Sungai Katibas).
3. Sungai Jik (tributary of Sungai Katibas) and tributaries (1.6493N, 112.2627E).
4. Sungai Datai (tributary of Sungai Katibas) and tributaries (1.6502N, 112.2796E).
5. Sungai Satap (tributary of Sungai Katibas) and tributaries (1.6537N, 112.251E).
6. Sungai Nyungan (tributary of Sungai Katibas) and tributaries (1.6572N, 112.2432E).
7. Sungai Pemanca (tributary of Sungai Katibas) and tributaries (1.6445N, 112.2772E).
8. Sungai Kelimau Besai (tributary of Sungai Katibas) and tributaries (1.6389N, 112.2684E). Fig. 7.
9. Sungai Kelimau Mit (tributary of Sungai Katibas) and tributaries (1.6435N, 112.2669E).
10. Sungai Merating (tributary of Sungai Bloh) and tributaries (1.634N, 112.289E).
11. Sungai Sekawie (tributary of Sungai Katibas) and tributaries (1.6558N, 112.248E).
12. Bearded Pig wallow on Sekawie Trail (1.6663N, 112.2488E).
13. Small, high gradient streams near Sekawie Trail (1.6558N, 112.248E, altitude at head of stream ca 360m a.s.l.); these appear to be the upper parts of Sungai Lait (tributary of Sungai Katibas), a stream not yet sampled further down.
14. Sungai Joh (tributary of Sungai Bloh) and tributaries (1.6286N, 112.3007E).
15. Sungai Woud (tributary of Sungai Bloh) and tributaries (1.6404N, 112.2847E).
16. Sungai Katibas (sampled between Sungai Datai and Sungai Gindi), including back waters and trickles at side, except trickles at Bukit Tuning (see below); (representative coordinates at the mouth of Sungai Nyungan: 1.6572N, 112.2432E); Fig. 8.
17. Sungai Begua (tributary of Sungai Katibas) and tributaries (1.6568N, 112.2336E).
18. Sungai Gindi (tributary of Sungai Katibas) and tributaries (1.6292N, 112.221E).
19. Trickles at Bukit Tuning landing place (1.6294N, 112.2199E).
20. Sungai Bedawak (tributary of Sungai Katibas) and tributaries (1.638N, 112.2216E).
21. Sungai Menyari (tributary of Sungai Katibas) and tributaries (1.6547N, 112.2285E).
22. Sungai Bloh sampled between mouth (1.6456N, 112.2791E) and (1.6259N, 112.3117E); (representative coordinates at the mouth of Sungai Merating: 1.634N, 112.289E).
23. Small streams in Sungai Bedawak area but on opposite bank of Sungai Katibas (1.6376N, 112.2221E).
24. Sungai Melinau (tributary of Sungai Katibas) and tributaries (1.6416N, 112.2232E).
25. Sungai Bugap (tributary of Sungai Bloh) and tributaries (coordinates not taken).

Nanga Segerak
Altitude on sampled parts of Sungai Engkari ca 330-350m. The locations of some of the sampling sites are shown in Fig. 9.
27. Tributaries to Sungai Engkari inside boundary (representative coordinates 1.4168N, 112.0101E).
28. Tributaries to Sungai Segerak inside boundary (representative coordinates 1.4115N, 112.0091E).
30. Tributary to Sungai Jela (1.4338N, 111.9997E).
31. Stream below Ubah Ribu (1.4383N, 111.9945E, ca 700m a.s.l. at head).

![Map of sampling sites in Nanga Segerak area](image_url)

Figure 9. Satellite image showing some of the sampling sites in the Nanga Segerak area. Base image from Google Earth.
Ulu Mujok
Altitude on sampled parts of Sungai Mujok ca 120-150m. The locations of some of the sampling sites are shown in Fig. 10.

32. Sungai Mujok upstream of LEWS boundary (representative coordinates at Nanga Sepulau: 1.683N, 112.1657E); Fig. 11, 12.
33. Sungai Temurok upstream of LEWS boundary (1.7035N, 112.1351E).
34. Sungai Sengkadan inside LEWS boundary (1.6817N, 112.1519E).
35. Sungai Sentara inside LEWS boundary (coordinates not taken).
36. Sungai Segak Mit (coordinates at mouth, shared with location 37; 1.6825N, 112.1579E).
37. Sungai Segak Besai (1.6825N, 112.1579E).
38. Sungai Selabi (1.6839N, 112.1605E).
40. Small stream on right side Sungai Mujok (going upstream) between Sungai Sepuna and Sungai Sepulau (1.6824N, 112.1647E).
41. Sungai Sepulau Mit (coordinates at mouth, shared with location 42; 1.683N, 112.1657E).
42. Sungai Sepulau Besai (1.683N, 112.1657E).
43. Sungai Tekalit (1.6759N, 112.1749E).
44. Small streams at Bukit Tanggan (1.6757N, 112.1504E).
45. Bearded Pig wallow on way to Bukit Tanggan.

![Figure 10. Satellite image showing some of the sampling sites in the Nanga Ju area. Base image from Google Earth.](image-url)
Figure 11. Pushing the prahu through a shallow section of Sungai Mujok on route to our campsite at the LEWS boundary. Photo by R.W.J. Ngiam.

Figure 12. Sungai Mujok inside the LEWS boundary (location 32). Photo by R.W.J. Ngiam.
List of species

Collectors names are abbreviated as follows (anak abbreviated as ak): names of authors, except Nickson Robi, as SB, CYC, RD, RN, GR; MA – M. ak Adau; JA – J. Awan; EJ – E. ak Jangoh; NMa. – N. ak Masii; SM – S. ak Maurice; BM – B. ak Megong; Nme. – N. ak Men-giring, LS – Luke Southwell.

Zygoptera

Platystictidae

Drepanosticta actaeon Laidlaw, 1934

See Dow (2017) for a discussion of this species and details of specimens collected before 2017 (locations 3, 5, 27, 30, 31).


Drepanosticta adenani Dow & Reels, 2018

A new species found in the Ulu Engkari (2016) and Nanga Bloh (2017) areas of LEWS; see Dow & Reels (2018) for details. Locations 4, 30.

Drepanosticta attala Liettinck, 1934

Loc 4: ♀, 10.iii.2016, RD.

Drepanosticta species cf crenitis Liettinck, 1933


Drepanosticta species cf dentifera Kimmins, 1936


Drepanosticta dulitensis Kimmins, 1936


Drepanosticta species cf forticula Kimmins, 1936

Loc 10: ♂, 25.viii.2013, RD.

Drepanosticta rufostigma (Selys, 1886)

All material not collected by CYC prior to 2017 is listed in Dow (2017; locations 2, 3, 6, 7, 9, 10, 18, 21, 27, 28, 30, 31, 36, 37, 38, 41, 44), where this species is also discussed. Fig. 13 shows a male.


![Figure 13. Drepanosticta rufostigma. Photo by C.Y. Choong at Nanga Bloh.](image)

**Drepanosticta sbong** Dow, 2010

This peculiar species was described from both sexes from a non-protected site near Kapit Town (Dow 2010); all other records are from LEWS and are presented here for the first time. Until 2017 all records were of single individuals or at most a pair, but in late 2017 five males were collected on a small, steep second order tributary to Sungai Datar at Nanga Bloh and at least as many again were seen, and three individuals were found in another small stream in the same period. Males were observed flying actively and competing for perches. Unfortunately the illustration of the lateral view of the anal appendages of the holotype in Dow (2010: fig. 5) is not entirely accurate, the paraproct is not drawn correctly, this was partly due to its position relative to the cercus in the holotype, but mostly due to the authors inexperience at illustration at the time; a fresh illustration from a specimen from LEWS is provided here (Fig. 14).

![Figure 14. Lateral view of the anal appendages of male Drepanosticta sbong from the Nanga Bloh area, scale bar 0.5mm.](image)


**Drepanosticta versicolor** (Laidlaw, 1913)

Fig. 15 shows a male.

Figure 15. *Drepanosticta versicolor*. Photo by C.Y. Choong at Nanga Bohl.

Telosticta longigaster Dow & Orr, 2012

Material collected by CYC in 2008 is listed in Dow & Orr (2012). With *D. rufostigma* this is the most common of the Platystictidae throughout the sampled areas of LEWS. Fig. 16 shows a male.

Figure 16. Telosticta longigaster. Photo by G.T. Reels at Nanga Segerak.


**Telosticta iban** Dow, 2014

This very distinctive species is only known from the type series from LEWS collected in 2013 in the Nanga Bloh area (see Dow 2014a); attempts to find it again have failed so far. Locations 9, 10.

**Telosticta** species

A female specimen, not the female of *T. iban* or *T. longigaster*, most similar to the female reported from Ulu Baleh in Dow & Ngiam (2014: 27).

**Loc 2**: ♂, 20.viii.2013, RD.

**Argiolestidae**

**Podolestes orientalis** Selys, 1862


**Podolestes** species

This is the same large size species, closely allied to *P. orientalis*, recorded from Batang Ai National Park in Dow et al. (2015a), Usun Apau National Park in Dow et al. (2015b), and the Ulu Moh area in Dow & Ngiam (2015).

**Loc 12**: ♂, 23.vii.2013, RD.
Calopterygidae

Neurobasis longipes Hagen, 1887

Fig. 17 shows a male.


**Figure 17.** Neurobasis longipes. Photo by C.Y. Choong at Nanga Bloh.

Vestalis amarylilis Lieftinck, 1965

Relatively uncommon at LEWS, compared with V. amoena and V. atropha.


Vestalis amnicola Lieftinck, 1965

Common in the Ulu Engkari area of LEWS, less so at Nanga Bloh and not yet found at Ulu Mujok.


**Vestalis amoena** Hagen in Selys, 1853

Very common in the Nanga Bloh and Ulu Mujok areas of LEWS.


**Vestalis atropa** Liettinsk, 1965


**Vestalis beryllae** Laidlaw, 1915


**Chlorocyphidae**

**Heliocypha biseriata** (Selys, 1859)


**Libellago semiopaca** (Selys, 1873)

**Loc 16:** ♂, 24.vi.2008, CYC; ♂, 23.viii.2013, JA & MA; ♂, 23.viii.2013, RD.

**Libellago stictica** Selys, 1859

Common on Sungai Katibas at Nanga Bloh. Fig. 18 shows a male.


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**Figure 18. Libellago stictica.** Photo by C.Y. Choong at Nanga Bloh.

**Rhinocypha aurfulgens** Laidlaw, 1931

Fig. 19 shows a pair in the wheel position.

Figure 19. *Rhinocypha aurofulgens* in the wheel. Photo by C.Y. Choong at Nanga Bloh.

*Rhinocypha cucullata* (Selys, 1873)

Fig. 20 shows a male.

Rhinocypha stygia Förster, 1897

Recorded in Norma-Rashid et al. (2010) as R. cognata Kimmins, 1936; see Hämäläinen (2009) for a discussion of the status of R. cognata as a junior synonym of R. stygia. A very local species in Sarawak, but fairly common in the Nanga Bloh area of LEWS.


Rhinocypha species cf spinifer Laidlaw, 1931

**Loc 10:** ♀, at steep tributary, 6.xi.2017, RD. **Loc 27:** ♀, 21.vii.2016. GR.

Sundacypha petiolata (Selys, 1859)

Fig. 21 shows a male.

Figure 21. Sundacypha petiolata. Photo by C.Y. Choong at Nanga Bloh.

Devadattidae

Devadatta clavicauda Dow, Hämäläinen & Stokvis, 2015

See Dow, Hämäläinen & Stokvis (2015) for material not collected by CYC before 2015.


Devadatta somoh Dow, Hämäläinen & Stokvis, 2015

See Dow, Hämäläinen & Stokvis (2015) for material not collected by CYC before 2015. Common in LEWS.

Euphaeidae

**Dysphaea dimidiata** (Selys, 1853)

Material collected prior to 2015 (except by CYC) is listed in Hämäläinen, Dow & Stokvis (2015).


**Dysphaea lugens** (Selys, 1873)

These records are the only ones in recent decades from Sarawak. In March 2016 the species was found over deep water on the Sungai Katibas and in a shallower section, but isolated by deep water, on the Sungai Bloh. In 2017 two males caught by RD were flying over almost waist deep water immediately upstream of a rapid. Perhaps one of the reasons that there have been few records of this species in recent decades (see Hämäläinen, Dow & Stokvis 2015) is a preference for larger streams with deep water and rapids, and which are therefore difficult to sample.


**Dysphaea ulu** Hämäläinen, Dow & Stokvis, 2015

Material collected prior to 2015 (except by CYC) is listed in Hämäläinen, Dow & Stokvis (2015).


**Euphaea species cf basalis** (Laidlaw, 1915)

**Euphaea basalis** is a montane species, originally described from Mount Kinabalu in Sabah, but in recent years found at some locations in Sarawak (e.g. the Hose Mountains, see Dow et al. 2015a). However the present record, from a site at 600-700m on Bukit Lanjak, is from significantly further west than any other, and from lower altitude. Also the behaviour exhibited by the Bukit Lanjak form was extremely fugitive, staying high in the canopy until the sun had been out for a considerable time and then still rarely descending to any spot at catchable height, and extremely wary, so that it was only possible to catch a single specimen. The status of this taxon is a subject of ongoing investigation.

**Loc 31**: ♂, 19.vii.2016, RD.

**Euphaea impar** Selys, 1859

Euphsea subcostalis Selys, 1873

Extremely abundant in LEWS.


Euphsea subnodalis (Laidlaw, 1915)

The records from Ulu Engkari presented here are the most western yet known for this species.

Loc 26: 3, 14.08.2016, RD; 2 3, 14.08.2016, GR. Loc 29: 3, 19.08.2016, RD.

Euphsea tricolor Selys, 1859

**Philosinidae**

*Rhinagrion borneense* (Selys, 1886)

Fig. 22 shows a male.


![Image of Rhinagrion borneense](image-url)

**Figure 22.** *Rhinagrion borneense.* Photo by C.Y. Choong at Nanga Bloh.
**Platycnemididae**

**CoelICCia borneensis (Selys, 1866)**

It is possible that more than one species is included in the material below; C. borneensis is by far the most problematic member of the species group that bears it name.


**CoelICCia campioni Laidlaw, 1918**

Much scarcer, at least at the altitudes that we have sampled at, than the previous species in LEWS; LEWS appears to be at the western edge of the range of this species.


**CoelICCia cyaneothorax Kimmins, 1936**


**CoelICCia species cf nemoricola Laidlaw, 1912**

Although not among specimens collected by the second author during the 2008 expedition, Norma-Rashid et al. (2010) recorded CoelICCia nemoricola. It is assumed here that this in fact refers to a relatively common species found throughout Sarawak (see, for instance, Dow & Ngiam 2012, 2015, Dow & Reels 2013), including in the lowlands, rather than the true C. nemoricola which only occurs at higher altitudes from the Tama Abu range in Miri and Limbang divisions and north and eastwards into the Crocker Range in Sabah. Subsequently we have collected this species in LEWS.

**Loc 18:** ♀, 9.iii.2016, RD. **Loc 28:** 4 ♀, 17.vii.2016, RD.
Coeliccia nigrohamata Laidlaw, 1918


Copera vittata (Selys, 1863)


"Elattoneura" analis (Selys, 1860)


"Elattoneura" mauros Dow, Choong & Ng, 2010

Initially misidentified as Elattoneura coomansii Lieftinck, 1937 (Norma-Rashid et al. 2010), this species remains known only from LEWS. Unfortunately the location where the holotype and four of the paratypes were collected was mistakenly given as Sungai Begua (Loc 17 here) when it was actually Sungai Jik (Loc 3 here) in Dow et al. (2010). The species is found hanging on steep banks and on overhanging vegetation at the side of the Katibas and Bloh, and sometimes just inside the mouths of tributary streams, often over water that is waist deep or more; most records are from near to stream mouths but in 2017 individuals were collected at some points remote from any stream mouth. Only material not in the type series is listed here. Fig. 23 shows a male.
Figure 23. “Elattoneura mauroso”. Photo by C.Y. Choong at Nanga Bloh.


**Prodasineura dorsalis** (Selys, 1860)


**Prodasineura hosei** (Laidlaw, 1913)


**Prodasineura hyperythra** (Selys, 1886)


**Prodasineura verticalis** (Selys, 1860)

**Loc 3**: ♂, 16.iii.2016, BM & MA. **Loc 4**: ♂♀, 10.iii.2016, RD. **Loc 9**: ♂, 24.viii.2013, RD. **Loc 10**:}

**Coenagrionidae**

*Agriocnemis femina* (Brauer, 1868)

**Loc 1:** ♂, 18.vi.2008, CYC; 4 ♂♂, 2 ♀♀, 20.vi.2008, CYC.

*Argiocnemis* species

**Loc 5:** 2 ♂♂, 23.viii.2013, RD. **Loc 6:** ♂, 14.iii.2016, RD.

*Ceriagrion bellona* Laidlaw, 1915

**Loc 1:** ♀, 20.viii.2013, JA, MA & AP.

*Pericnemis dowi* Orr & Hämäläinen, 2013

**Loc 5:** ♂, 16.iii.2016, RD. **Loc 13:** ♀, on steep slope above stream, 9.xi.2017, BM.

**Loc 31:** ♂, 19.vii.2016, RD. **Loc 36:** ♂, 30.vii.2015, RD. **Loc 37:** ♀, 16.viii.2016, LS.

*Pericnemis kiautaran* Orr & Hämäläinen, 2013

**Loc 1:** ♂, at lights in the field station in the early evening, 12.iii.2016, RD.

*Pseudagrion microcephalum* (Rambur, 1842)

**Loc 16:** ♂, 14.iii.2016, BM. **Loc 18:** ♂, 9.iii.2016, RD.

*Stenagrion dubium* (Laidlaw, 1912)


*Teinobasis laidlawi* Kimmins, 1936


**Incertae sedis**

*Bornargiolestes fuscus* Dow, 2014

See Dow (2014b) for material collected before 2016. It should be noted that only females have been found in LEWS so far, and the specimen available at the time
Dow (2014b; from Location 5 as defined here) was published was left out of the type series of B. fuscus because of this and differences in colouration from typical examples found with males in Lambir Hills and on Gunung Mulu; some doubt remains over whether the form found in LEWS is really B. fuscus, this issue will only be resolved when males are found there.

**Loc 6**: ♀, 14.iii.2016, RD. **Loc 20**: ♀, 4.xi.2017, RD.

### Anisoptera

#### Aeshnidae

*Heliaeschna* species

**Loc 2**: ♀, 21.vi.2008, CYC.

*Indaeschna grubaueri* (Förster, 1904)


*Tetracanthagyna degorsi* Martin, 1896


### Gomphidae

*Acrogomphus jubilaris* Lieftinck, 1964

*Acrogomphus* larvae (see Butler et al. 2016 for a discussion of this genus in Borneo) from LEWS are assumed here to belong to *A. jubilaris*, although the presence of additional *Acrogomphus* species in Borneo cannot be ruled out.

**Loc 6**: 2 larvae, 14.iii.2016, SB. **Loc 19**: 2 larvae, 9.iii.2016, SB. **Loc 20**: larva, 10.iii.2016, SB. **Loc 21**: 3 larvae, 15.iii.2016, SB.

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**Figure 24. Burмагomphus insularis. Photo by C.Y. Choong at Nanga Bloh.**
Burmagomphus insularis Laidlaw, 1914
Another poorly known species. Fig. 24 shows a male.

**Loc 16:** ♂, 25.vi.2008, CYC; ♂, 7.xi.2017, RD. **Loc 22:** ♀, 11.xi.2017, SM.

Gomphidia caesarea Lief tinck, 1929
This species was described from West Kalimantan (Lief tinck 1929) and had remained unrecorded again until CYC collected a male in LEWS in 2008.

**Loc 16:** ♂, 24.vi.2008, CYC.

Gomphidia maclachlani (Selys, 1873)

**Loc 3:** ♀, 21.viii.2013, RD. **Loc 21:** ♂, 11.iii.2016, RD. **Loc 32:** ♂, 21.viii.2016, BM & NMe. **Loc 39:** ♂, 18.viii.2016, BM & NMe. **Loc 42:** ♂, 18.viii.2016, LS.

Heliagomphus cf. blandulus Lief tinck, 1929
At present the Bornean Heliagomphus present considerable taxonomic difficulties.

**Loc 32:** ♂ (teneral), 21.viii.2016, RD.

Heliagomphus ?borneensis Lief tinck, 1963

**Loc 33:** ♀ (teneral), 1.viii.2015, RD.

Leptogomphus coomans Laidlaw, 1936
See Dow, Stokvis & Ngiam (2017) for adult records. Locations 32, 34, 36, 37, 38, 43.

Leptogomphus species cf. coomans Laidlaw, 1936
See Dow, Stokvis & Ngiam (2017) for adult records up to 2016 and a discussion of the status of this form.

**Loc 8:** ♂ (teneral), 3.xi.2017, RD. **Loc 17:** ♂ (teneral), 10.xi.2017, BM & MA. **Loc 33, Loc 38.**

Leptogomphus pendleburyi Laidlaw, 1934
See Dow, Stokvis & Ngiam (2017) for records to 2016.

**Loc 3:** ♂ (teneral), 8.xi.2017, RD. **Loc 6.** **Loc 13:** ♀, 9.xi.2017, BM & MA. **Loc 17:** ♀ (teneral), 10.xi.2017, RD. **Loc 44.**

Leptogomphus sii Dow, Stokvis & Ngiam, 2017

Leptogomphus williamsoni Laidlaw, 1912
See Dow, Stokvis & Ngiam (2017) for adults collected.

**Loc 2.** **Loc 6:** 1 larva, 14.iii.2016, SB. **Loc 13:** larva, 26.viii.2013, AP. **Loc 20:** ♀, 4.xi.2017, RD. **Loc 21.** **Loc 27.** **Loc 28.**

Macrogomphus quadratus Selys, 1878

**Loc 20:** 4 larvae, 10.iii.2016, SB. **Loc 21:** 3 larvae, 15.iii.2016, SB.

Megalogomphus icterus (Martin, 1902)
Fig. 25 shows a male.

**Loc 32:** ♂, 17.viii.2016, RD; ♂, 20.viii.2016, RD.

Megalogomphus cf. sumatr anus (Krüger, 1899)

**Loc 3:** ♂, 8.xi.2017, MA; ♂, 8.xi.2017, RD. **Loc 4:** ♂, 22.viii.2013, JA & MA; ♂, 10.iii.2016, RD. **Loc 20:** ♂, 2 ♀♀, 10.iii.2016, SFC staff.
Merogomphus species

Unfortunately the anal appendages, already distorted, of two teneral males collected in LEWS shrivelled after preservation, however the appendages were at least close to those of *M. femoralis* Laidlaw, 1931 (the only *Merogomphus* species known from Sarawak until now, see Dow & Unggang 2010) and the markings are in fairly good agreement, however the size is significantly smaller; possibly this is a new species or a new record for Borneo but mature specimens are required to determine this. Both males were caught at the mouths of tributaries of the Katibas, perched in vegetation above waist deep water over sediment substrates.

**Loc 10**: ♂ (teneral), just inside mouth, 6.xi.2017, RD. **Loc 16**: ♂ (teneral), at mouth of Sungai Kelimau Besal, 3.xi.2017, RD.

*Micogomphus chelifer* (Selys, 1858)


*Microgomphus* species cf *chelifer* (Selys, 1858)


These are only the second records of this species, first described from Sabah (see Dow & Luke 2014). The first author of Dow & Luke (2014) and this paper may have been premature in placing this species and *Onychogomphus treadwayi* Müller & Hämäläinen, 1993 in *Phaenandrogomphus*: in doing so he overlooked, for instance, *Nychogomphus* Carle, 1986, which has a very similar penile organ. In fact the closest relative to *P. safei* now appears to be *Onychogomphus duaricus* Fraser, 1924, which is often placed in *Nychogomphus*. With hindsight it would have been better to take
a conservative approach and describe this species in Onychogomphus pending a thorough genus level revision of the Asian Onychogomphinae.

On November 7, 2017, when water levels were relatively low on the Katibas, the river was running very clear, and the sun was out brightly from early, two or more males were seen flying immediately upstream of every rapid passed on the river and three males were collected; the species had not been spotted at these locations previously, and on subsequent days, when conditions were less good, a few individuals only were seen at these locations. The undescribed female (supposition, but the specimen is very similar to the males in its markings and size) was found perched on vegetation overhanging the Sungai Bloh a few days later. Fig. 26 shows the male collected at ulu Mujok.


![Figure 26. Phaenandrogomphus safeii. Photo by R.W.J. Ngiam at Sungai Mujok.](image)

![Figure 27. Sieboldius japonicus. Photo by R.W.J. Ngiam at Sungai Mujok.](image)
Sieboldius japonicus (Selys, 1854)

Fig. 27 shows a male.

**Loc 16:** ♂, 23.vi.2008, CYC; ♂, 7.xi.2017, RD. **Loc 32:** ♂, 18.viii.2016, RD. Also seen at locations 14 and 17.

Chlorogomphidae

**Chlorogomphus** species

It is entirely possible that more than one species is included here. Fig. 28 shows the female collected at Nanga Segerak.

**Loc 3:** larva, 21.viii.2013, AP. **Loc 19:** 2 larvae, 9.iii.2016, SB; **Loc 27:** 1 ♀, 15.vii.2016, GR. **Loc 34:** ♀ larva (reared), 16.viii.2016, RN.

![Figure 28. Chlorogomphus species female. Photo by G.T. Reels at Nanga Segerak.](image)

Macromiidae

**Macromia callisto** Laidlaw, 1922

There has been no clear record of this species from Borneo until now; Lieftinck (1971: caption to Fig. 11, page 25) illustrates the anal appendages of a male stated to be from Borneo, and gives some notes on the same male (stated to be in fragments) on page 24, but the specimen is not listed with the material studied on page 23. Presumably the specimen was simply omitted from the list of material, but it is unfortunate that no more information on the location is available. The record in Lieftinck (1971) has, unsurprisingly, been largely overlooked until now, and M. callisto was not listed from Borneo in Orr (2003).

**Loc 4:** 2 ♀♀, 10.iii.2016, RD. **Loc 5:** ♂, 23.viii.2013, RD; ♀, 24.viii.2013, RD. **Loc 6:** ♀, 14.iii.2016, EJ. **Loc 17:** ♀, 10.xi.2017, SM. **Loc 20:** ♀, 10.iii.2016, SFC staff.

**Macromia corycia** Laidlaw, 1922

Macromia cycippe Laidlaw, 1922


Macromia westwoodii Selys, 1874


**Synthemistidae**

Idionyx montana Karsch, 1891

The number of records of this species from Sarawak, where it was first recorded in Batang Ai National Park in 2007 (Dow et al. 2015a) is increasing slowly but surely (also see the appendix to this paper).

**Loc 30**: ♀, 18.vii.2016, GR.

Macromidia fulva Laidlaw, 1915


Macromidia genialis erratica Lieftinck, 1948

Larval records; molecular data (Naturalis unpublished) clearly indicates that these are not M. fulva, and places them with M. genialis erratica.

**Loc 3**: larva, 21.viii.2013, AP. **Loc 4**: larva, 22.viii.2013, AP.

**Libellulidae**

Cratilla lineata (Brauer, 1878)

Recorded by Norma-Rashid et al. (2010).

Cratilla metallicia (Brauer, 1878)


Hylaeothemis clementia Ris, 1909


Lyriothemis biappendiculata (Selys, 1878)

Lyriothemis cleis Brauer, 1868


Neurothemis fluctuans (Fabricius, 1793)


Onchothemis coccinea Lieftinck, 1953


Onchothemis culminicola Förster, 1904

This species appears to be rather common on the lower reaches of the Katibas River, but on the upper reaches O. coccinea dominates and far fewer O. culminicola are seen.


Orthetrum chrysis (Selys, 1891)


Orthetrum glaucum (Brauer, 1865)


Orthetrum pruinosum schneideri Förster, 1903


Orthetrum testaceum (Burmeister, 1839)

Recorded by Norma-Rashid et al. (2010).

Rheedothemis rufa (Rambur, 1842)

Recorded by Norma-Rashid et al. (2010).

Trithemis aurora (Burmeister, 1839)

Loc 26: ♂, 14.vii.2016, RD.

Trithemis festiva (Rambur, 1842)

Loc 26: ♂, 14.vii.2016, GR.

Tyriabapta kuekenthali (Karsch, 1900)

Loc 33: ♂, 4.viii.2015, RD.
Tyriobapta torrida Kirby, 1889


*Zygonyx ida errans* Lieftinck, 1953 stat. nov.

This taxon was described as a subspecies of *Z. iris* Selys, 1869 (Lieftinck 1953), but morphological evidence places it with *Z. ida* Hagen, 1867 not *Z. iris* and molecular data clearly differentiates it from *Z. iris*. This matter will be dealt with in more detail elsewhere (Dow in preparation), but as changes of status of subspecies are not regulated by the Zoological Code and we are tired of writing a name that we know to be incorrect, we introduce the change here.


*Zyxomma petiolatum* Rambur, 1842

Recorded by Norma-Rashid et al. (2010).

**Additional records of larvae, and teneral and female Anisoptera**

Various larvae from both suborders, and also some teneral specimens and mature females from three Anisopteran families cannot be assigned with confidence to any of the taxa in the list above at present, although at least some of them will belong under those taxa. These are listed here rather than above, in order to avoid both artificially inflating the number of species recorded from LEWS and unwarranted lumping.

*Zygoptera*

**Calopterygidae**

*Vestalis* species

**Loc 10:** 2 larvae, 9.iii.2016, SB.

**Chlorocyphidae**

Undetermined genus

**Loc 10:** larva, 9.iii.2016, SB.

**Platycnemididae**

*Coelicia* species

**Loc 10:** larva, 9.iii.2016, SB.
Anisoptera
Gomphidae
Burmagomphus and/or Merogomphus sp. or spp.
   **Loc 6**: 4 larvae, 14.iii.2016, SB.  **Loc 20**: 10 larvae, 10.iii.2016, SB.  **Loc 21**: 5 larvae, 15.iii.2016, SB.
Gomphidia sp. or spp.
   **Loc 6**: larva, 23.viii.2013, AP.  **Loc 20**: 2 larvae, 10.iii.2016, SB.
Heliogomphus spp.
   At least two species appear to be represented in this material.
Leptogomphus sp. or spp.
   It is highly likely that more than one species is included here.
Macrogomphus sp.
Megalogomphus sp. or spp.
   **Loc 6**: 3 larvae, 14.iii.2016, SB.  **Loc 20**: 3 larvae, 10.iii.2016, SB.  **Loc 21**: 3 larvae, 15.iii.2016, SB.
Microgomphus sp. or spp.
Onychogomphine species
   Although this is possibly the larva of *Phaenandrogomphus safeii*, it is just as likely that it is that of some other member of the Onychogomphinae the adult of which has yet to be detected at LEWS.
   **Loc 20**: larva, 10.iii.2016, SB.

Macromiidae
Macromia spp.
   Probably a number of species are represented in this material, which is nearly all larvae. One female specimen collected differs in some respects from the females of all identified species so far recorded at LEWS and is likely to represent an additional species.
Synthemistidae

Idionyx sp. or spp.


Macromidia species

Loc 22: larva, 14.iii.2016, SB.

Records in need of confirmation

Vestalis amabilis Lieftinck, 1965

Recorded by Norma-Rashid et al. (2010) as “moderate” in relative abundance but not recorded by CYC during the expedition or by us later. Moreover, V. amabilis is normally found only in habitats where other Vestalis species are absent, in contrast to other species of the amoena-group (except V. beryllae) which are often found together. This record might represent a misidentification of one of the other amoena-group species (probably V. amoena itself, which exhibits some variation in its superior anal appendages as seen in lateral view) and needs confirmation.

Prodasineura interrupta (Selys, 1860)

Recorded in Norma-Rashid et al. (2010) but not collected by the second author of this publication. In fact the Bornean taxon that has been referred to as P. interrupta is actually a distinct species (Dow & Ngiam in preparation). The record of a “singleton” from Lanjak Entimau might refer to this as-yet-unnamed species or one of its allies; however the habitats (mostly mixed dipterocarp forest) seen in the area of the Nanga Bloh Field Station by authors of this report are far from typical of the habitat of species of the interrupta-group in Borneo (usually low pH streams in peat swamp, kerapa and kerangas forest). We note that the blue form of Coelicia borneensis, common in LEWS, bears a superficial resemblance to P. interrupta.

Hemicordulia tenera Lieftinck, 1930

Recorded by Norma-Rashid et al. (2010). Again, the habitats at Nanga Bloh are far from typical of those where this species is normally recorded in Borneo, and we regard this record as requiring confirmation.

Risiophilebia dohmi (Krüger, 1902)

Recorded by Norma-Rashid et al. (2010). This is typically a species of swamp forest; but it is occasionally found in small swampy areas within other forest formations, so that its presence in the Nanga Bloh area of LEWS cannot be ruled out. However this record is regarded as needing further confirmation.

Incorrect Records

Devadatta podolestoides Laidlaw, 1934

Listed by Norma-Rashid et al. (2010) but actually refers to a mixture of D. clavicauda and D. somoh; in Sarawak the true D. podolestoides has not been recorded east of the Lupar River.
Vestalis anacolosa Lief tinck, 1965

Listed by Norma-Rashid et al. (2010). Vestalis anacolosa was described from Poring Hot Springs in Sabah (Lief tinck 1965) and was distinguished from V. atropha (type locality Mount Dulit) on the basis of its completely reduced inferior anal appendages, compared to thin and atrophied in V. atropha, there also appeared to be differences in the terminal part of the superior anal appendages. In central Sarawak many populations of V. atropha include a full spectrum between the condition of the inferior appendages as seen in typical V. atropha and in typical V. anacolosa, whilst apparent differences in the superior appendages are accounted for by the degree of rotation of the tip. It is very likely that the two species are synonymous, but in any event the population in Lanjak Entimau belongs to just one species, which is the same as V. atropha.

Libellago phaethon (Laidlaw, 1931)

Norma-Rashid et al. (2010) list this species from a “singleton” of unspecified sex. This species is otherwise known only from south-eastern Sabah and the immediately adjacent part of North Kalimantan; facts not remarked upon in Norma-Rashid et al (2010). The record from Lanjak Entimau would represent a remarkable range extension and cannot be accepted without further evidence.

Rhinoneura villosipes Laidlaw, 1915

As with the previous species Norma-Rashid et al. (2010) list this species from a “singleton” of unspecified sex, but in this case the record would be even more extraordinary as R. villosipes is a montane species only known from above 1000m on Mount Kinabalu in Sabah. The occurrence of this species in the lowlands of western Kapit Division would be truly remarkable and it is informative that no remark was made on this in Norma-Rashid et al. (2010). Without strong evidence to the contrary this record must be regarded as a misidentification of some other member of the Chlorocyphidae.

Elat toneura coomansi Lief tinck, 1937

This was a misidentification of E. mauros in Norma-Rashid et al. (2010) before it was recognised as a distinct species.

Pericnemis triangularis Laidlaw, 1931

Norma-Rashid et al. (2010) listed P. triangularis, however Orr & Hämäläinen (2013) noted that this species is actually only known from the type female from the east of Sabah and erected two new species for specimens previously treated as P. triangularis. It is not known which, if either, of the two Pericnemis species recorded in LEWS is referred to by the record of P. triangularis in Norma-Rashid et al. (2010), but it is extremely unlikely to be P. triangularis as it is currently understood.

Discussion

With at least 110 species already recorded, LEWS has an impressive Odonata fauna, especially since this figure includes relatively few open and disturbed habitat species; inventories for many protected areas receive a significant boost in species numbers from species not typical of their habitats but found at ponds in clearings
around buildings, but such habitats have added to the LEWS inventory only in a very limited way, with only 12 species genuinely falling into this category. There are undoubtedly more species to be found within LEWS, although ultimately its odonate diversity will be limited by at least two factors: (a) limited altitudinal range compared with, for instance, Gunung Mulu National Park; (b) limited range of habitat types compared with some other protected areas, e.g. there does not appear to be any real swamp forest within LEWS, although swampy areas exist, especially along sections of the larger rivers.

Three of the species recorded from LEWS have so far only been found within the borders of the wildlife sanctuary: *Drepanosticta adenani*, *Telosticta iban* and “*Elattoneura*” *mauros*. Of these, the two Platyictictidae are difficult to find species which, hopefully, have a wider distribution than we know at present. “*Elattoneura*” *mauros* is inconspicuous because of its dark colouration and habits, and therefore would easily be overlooked. It is very likely to occur further down the Katibas River and possibly on some of its larger tributaries outside of LEWS; it remains to be seen if it occurs outside of the Katibas system. Regardless of whether any or all of these three species occur outside of LEWS, the wildlife sanctuary is clearly of great value for their conservation.

The diversity of some stream systems at LEWS is also very notable (although probably typical of such systems in unlogged lowland forest in Sarawak), with more than 40 species found on several individual systems, only sampled over a relatively short part of their courses and over a few days, in the Nanga Bloh area. The only stream systems of comparable size with comparable recorded odonate diversity that we are aware of in Sarawak are within Gunung Mulu National Park.

The field stations are all outside or only just inside the boundary of LEWS, so that even at Nanga Bloh we have not been able to penetrate very far into the interior of the sanctuary. The most pristine habitats will be located in the deep interior where it would have been challenging for people to establish homes for themselves even in headhunting days when the incentives, from a safety point of view, for living in inaccessible locations were very high. It is difficult to work effectively far inside the sanctuary, camps must be set up, necessitating the transport of materials and provisions, but travel by long boat much past the points we have reached is either completely impractical for much of the year, or (for instance on the Katibas) requires a large number of highly skilled boatmen who can bring the boats through the numerous rapids safely. Similarly proceeding into the interior on foot will require many porters; both methods will be relatively costly, but are sure to be rewarding in odonatological terms. However, even nibbling around the edges, as we have been doing to date, will still bring worthwhile results, especially since we have not visited many parts of the boundary. Additionally, Bukit Lanjak, the highest peak in LEWS, can be reached from Nanga Segerak, but we have so far only gone a little over half of the way up and accessed only one stream system at this altitude; other peaks, in particular Bukit Spali, are located at the boundary and are potentially fruitful locations.

In addition to the three species only known from LEWS, a number of the other species recorded there appear to be rather rare or at least rarely recorded, for instance: *Drepanosticta sbong* (only one other, non-protected, location is known), *Dysphaea lugens* (no other location currently known in Sarawak), *Burromomphus insularis* (only
one other, non-protected, location currently known in Sarawak), *Gomphidia caesarea* (no other location currently known), and *Phaenandromorphus safeii* (no other location known in Sarawak, just one location known in Sabah).

Diversity is notably high in some families and genera in LEWS. The Platystictidae are very well represented with 13 species; this is the highest number for any protected area in Sarawak, surpassing even Gunung Mulu National Park. The Chlorocyphidae are also very diverse at LEWS with eight species recorded, as are the Euphaeidae where the only species known from Borneo definitely not recorded at LEWS is *Euphaea ameeka* van Tol & Norma-Rashid, 1995. The Platycnemididae are well represented and it is noteworthy that although with six species recorded the Disparoneurinae cannot be considered especially well represented, they are well represented compared to some other hilly and mountainous areas in the interior of Sarawak. The Gomphidae are very well represented with at least 19 species, this is the highest total of any protected area in Borneo as far as we are aware. However some families are poorly represented: the Argiolestidae, Coenagrionidae, Aeshnidae and Libellulidae; this is due to the lack of swamp forest and/or open habitats favoured by most species from these families. As yet there is no record of the Lestidae from LEWS, but *Orolestes wallacei* (Kirby, 1889) is to be expected.

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**References**


Appendix: Unpublished records from areas adjacent to LEWS

Locations

Sri Aman Division: Ulu Engkari

UE1: Sungai Engkari from Rumah Bada to Nanga Segerak (representative coordinates 1.4057N, 111.9964E).

UE2: Sungai Segerak (1.4119N, 112.0052E).

UE3: Around Nanga Segerak Field station (1.4138N, 112.0045E), helipad and trail to Rumah Bada.

UE4: In NCR land around Rumah Bada.

UE5: Ponds at Rumah Bada (Rumah Bada: 1.3903N, 111.9851E).

Sariki Division: Sungai Kanowit

SK1: Sungai Kanowit at bridge on road leading to Ulu Mujok area (1.729N, 111.9937E).

SK2: Pond by road near bridge at SK1.

Sariki Division: Ulu Mujok

UM1: Sungai Mujok between SFC field station and boundary of the wildlife sanctuary (representative coordinates 1.7023N, 112.1018E, at Rumah Mening, the last longhouse on the Sungai Mujok). Broad stream passing through mosaic of primary and second growth forest and agricultural land.
UM2: Pools beside Sungai Mujok, near Rumah Menging: pools at rear of pebbly beach beside large stream.
UM4: Sungai Telau (1.7014N, 112.104E). Stream passing through agricultural land and disturbed forest.
UM5: Sungai Selumau (1.6960N, 112.0936E). Stream passing through agricultural land and disturbed forest.
UM7: Small, old, oxbow lakes and other ponds by Sungai Ju (1.7103N, 112.0754E).
UM8: Sungai Lingga (1.6952N, 112.1209E). Stream in disturbed and almost pristine forest.
UM10: Sungai Temurok downstream of LEWS boundary (1.6917N, 112.1299E). Stream in forest of increasingly good quality going upstream.
UM11: Sungai Sengkadan downstream of LEWS boundary.

**List of species**
Abbreviations for collector’s names are as used in the main body of the paper.

**Zygoptera**

**Platystictidae**

*Drepanosticta attala* Lieftinck, 1934

Loc UM1: ♂, 30.vii.2015, RD; ♂, 6.viii.2015, RD.

*Drepanosticta* species cf *crenitis* Lieftinck, 1933

Loc UM3: ♂, 29.vii.2015, RD.

*Drepanosticta dulitensis* Kimmins, 1936

Loc UM5: 2 ♂♂, 2.viii.2015, RD.

*Drepanosticta* species cf *forticula* Kimmins, 1936

Loc UM5: ♂, 2.viii.2015, RD.

*Drepanosticta rufostigma* (Selys, 1886)


*Drepanosticta versicolor* (Laidlaw, 1913)


*Telosticta longigaster* Dow & Orr, 2012

Loc UM5: 2 ♂♂, 2 ♀♀, 2.viii.2015, RD. Loc UM6: 3 ♂♂, 3.viii.2015, RD.
**Argiolestidae**

*Podolestes orientalis* Selys, 1862

**Loc UM5**: 2 ♂, ♀, 2.viii.2015, RD.

**Calopterygidae**

*Neurobasis longipes* Hagen, 1887


*Vestalis amaryllis* Lieftinck, 1965


*Vestalis amnicola* Lieftinck, 1965


*Vestalis amoena* Hagen in Selys, 1853


*Vestalis atropha* Lieftinck, 1965

**Loc UM5**: ♂, 2.viii.2015, RD. **Loc UM6**: ♂, 3.viii.2015, NMa

**Chlorocyphidae**

*Heliochypha biseriata* (Selys, 1859)


*Libellago semiopaca* (Selys, 1873)

**Loc SK1**: ♂, 12.viii.2016, RD; ♂, 12.viii.2016, RN.

*Libellago stictica* (Selys, 1859)

**Loc UM1**: ♂, 6.viii.2015, RD; ♂, 7.viii.2015, NMa; ♂, 15.viii.2016, BM & NMe. **Loc UM6**: ♂, 3.viii.2015, RD.

*Rhinocypha aurofulgens* Laidlaw, 1931


*Rhinocypha cuculata* (Selys, 1873)

**Rhinocypha stygia** Förster, 1897

**Loc UM8:** ♂, 5.vii.2015, RD.

**Sundaclys petiolata** (Selys, 1859)

**Loc UM5:** 2 ♀♂, 2.vii.2015, RD. **Loc UM8:** 2 ♀♂, 5.vii.2015, RD. **Loc UM11:** ♂, 16.viii.2016, RN.

**Devadattidae**

**Devadatta cliviaudua** Dow, Hämäläinen & Stokvis, 2015

**Loc UE4:** ♂, 22.vii.2016, RD. **Loc UM3:** ♂, ♀, 29.vii.2015, RD. **Loc UM4:** ♂, 31.vii.2015, RD. **Loc UM5:** 3 ♀♂, 2.vii.2015, RD. **Loc UM8:** 2 ♀♂, ♀, 5.vii.2015, RD. **Loc UM9:** ♂, 7.vii.2015, RD. **Loc UM10:** ♀, 4.vii.2015, RD.

**Devadatta somoh** Dow, Hämäläinen & Stokvis, 2015

**Loc UM5:** 4 ♀♂, 2.vii.2015, RD. **Loc UM6:** 2 ♀♂, 3.vii.2015, RD.

**Euphaeidae**

**Dysphacia dimidiata** (Selys, 1853)

**Loc UM1:** 4 ♀♂, 30.vii.2015, RD; 2 ♀♂, ♀, 7.vii.2015, RD; ♀, 7.vii.2015, NMa. **Loc UM8:** 2 ♀♂, 5.vii.2015, RD.

**Dysphacia ulu** Hämäläinen, Dow & Stokvis, 2015

**Loc Loc UE1:** 4 ♀♂, 13.vii.2016, RD. **Loc UM8:** ♂ (teneral), 5.vii.2015, RD.

**Euphaea impar** Selys, 1859

**Loc UE4:** ♂, 22.vii.2016, RD. **Loc UM3:** 4 ♀♂, ♀, 29.vii.2015, JA & NMa; 2 ♀♂, 29.vii.2015, RD. **Loc UM5:** ♂, 2.vii.2015, RD; ♀, 2.vii.2015, NMa. **Loc UM6:** 2 ♀♂, 3.vii.2015, RD. **Loc UM8:** ♂, 5.vii.2015, RD. **Loc UM10:** ♀, 4.vii.2015, NMa. **Loc UM11:** ♂, 16.viii.2016, RN.

**Euphaea subcostalis** Selys, 1873

**Loc UM3:** ♂, 29.vii.2015, RD. **Loc UM5:** ♂, 2.vii.2015, RD; 2 ♀♂, 2.vii.2015, NMa. **Loc UM8:** ♂, 5.vii.2015, RD. **Loc UM11:** ♂, 16.viii.2016, RN.

**Euphaea subnodalis** (Laidlaw, 1915)

**Loc UE1:** 3 ♀♂, 13.vii.2016, RD; 2 ♀♂, 13.vii.2016, GR.

**Euphaea tricolor** Selys, 1859


**Philosiniidae**

**Rhinagrion borneense** (Selys, 1886)

Platycnemididae

Coeliccia borneensis (Selys, 1866)

*Loc UM5*: ♂, 2.viii.2015, RD.

Coeliccia cyaneothorax Kimmins, 1936


Coeliccia nigrohamata Laidlaw, 1918


Copera vittata (Selys, 1863)


“Elattoneura” analis (Selys, 1860)


Prodasineura hosei (Laidlaw, 1913)


Prodasineura hyperythra (Selys, 1886)


Prodasineura verticalis (Selys, 1860)


Coenagrionidae

Agriocnemis femina (Brauer, 1863)

*Loc UE5*: ♀, 22.vii.2016, RD.

Agriocnemis species


*Loc UM5*: ♂, 2.viii.2015, RD. *Loc UM7*: 2 ♂♂, 3.viii.2015, RD; ♂, 3.viii.2015, NMa

Ceriagrion cerinorubellum (Brauer, 1865)

*Loc SK2*: ♀, 12.vii.2016, RD.

Pseudagrion lalakense Orr & van Tol, 2001

*Loc SK2*: ♂, 12.viii.2016, RD.

Pseudagrion perfuscatum Lieftinck, 1937


Stenagrion dubium (Laidlaw, 1912)

Teinobasis laidlawi Kimmins, 1936

**Loc UM7:** ♂, 3.viii.2015, RD.

Anisoptera

Aeshnidae

*Heliaeschna* species

**Loc UM5:** ♀, 2.viii.2015, RD.

Gomphidae

*Heliogomphus borneensis* Lieftinck, 1963

**Loc UM5:** ♂ (teneral), 2.viii.2015, RD.

*Ictinogomphus decoratus melaenops* (Selys, 1858)

**Loc UM1:** ♂, 30.vii.2015, RD.

*Leptogomphus coomansi* Laidlaw, 1936


*Macrogomphus parallelogramma albardae* (Selys, 1878)

**Loc UM1:** ♀, 6.viii.2015, RD.

*Megalogomphus icterops* (Martin, 1902)

**Loc UM1:** ♂, 1.viii.2015, RD.

*Sieboldius japonicus* (Selys, 1854)

**Loc UM1:** ♂, 6.viii.2015, RD; ♂, 6.viii.2015, EJ; ♂, 13.viii.2016, RN.

Macromiidae

*Macromia corycia* Laidlaw, 1922

**Loc UE1:** ♀, 13.vii.2016, RD.

*Macromia westwoodii* Selys, 1874

**Loc UE1:** ♀, 13.vii.2016, EJ.

Synthemistidae

*Idionyx montana* Karsch, 1891

**Loc UM1:** ♂, 6.viii.2015, NMa

*Idionyx yolanda* Selys, 1871

**Loc UM8:** ♂, hawking over small trail near stream, 5.viii.2015, RD.

*Idionyx* sp. or spp.

**Loc UM1:** ♀, 13.vii.2016, RN; 2 ♀♀, 21.viii.2016, LS. **Loc UM5:** ♀, 2.viii.2015, NMa.

**Loc UM6:** ♀, 3.viii.2015, NMa.

*Macromidia fulva* Laidlaw, 1915

**Loc UM1:** ♀, 5.viii.2015, RD.
**Libellulidae**

*Brachydiplax chalybea* Brauer, 1868

**Loc UE5**: ♂, 22.vii.2016, GR.

*Cratilla lineata* (Brauer, 1878)

**Loc SK2**: ♂, 22.viii.2016, RD. **Loc UM4**: ♂, 31.vii.2015, JA.

*Cratilla metallica* (Brauer, 1878)


*Hylaeothemis clementia* Ris, 1909

**Loc UM9**: 2 ♂♂, 7.vii.2015, RD.

*Lyriothemis biappendiculata* (Selys, 1878)


*Lyriothemis cleis* Brauer, 1868

**Loc UM1** (at camp site) – ♂, 19.viii.2016, RD.

*Neurothemis fluctuans* (Fabricius, 1793)


*Neurothemis ramburii* (Brauer, 1866)

**Loc UM2**: ♂, 6.viii.2015, NMa

*Neurothemis terminata* Ris, 1911

**Loc UM1**: ♂, 21.viii.2016, LS.

*Onychothemis coccinea* Lieftinck, 1953


*Onychothemis culminicola* Förster, 1904

**Loc SK1**: ♂, 12.viii.2016, RN.

*Orthetrum chrysis* (Selys, 1891)

**Loc UE1**: ♂, 13.vii.2016, RD. **Loc UM4**: ♂, 31.vii.2015, JA.

*Orthetrum glaucum* (Brauer, 1865)

**Loc Loc UE1**: ♂, 13.vii.2016, GR. **Loc UM1**: ♂, ♂, 6.viii.2015, NMa. **Loc UM3**: ♂, 29.vii.2015, JA & NMa

*Orthetrum pruinosum schneideri* Förster, 1903


*Orthetrum sabina* (Drury, 1770)

**Loc UE3**: ♂, 21.vii.2016, RD.

*Orthetrum testaceum* (Burmeister, 1839)

**Loc UE5**: ♂, 22.vii.2016, RD. **Loc UM4**: ♂, 31.vii.2015, RD.
Rhyothemis triangularis Kirby, 1889

Loc UE5: ♂, 22.vii.2016, RD.

Tetraphemis hyalina Kirby, 1889


Trithemis aurora (Burmeister, 1839)


Tyriobapta torrida Kirby, 1889


Zygonyx ida errans Lieftinck, 1953


Zyxomma petiolatum Rambur, 1842

Loc UM1: ♂, 6.viii.2015, NMa; ♀, 7.viii.2015, NMa.
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